Pseudo-CR Performance evaluation of AL-FEC and MCS dimensionning

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1. Introduction

In SA4#93, SA4 has initiated the FS_FEC_MCS study item about the applicability of FEC schemes to mission critical services, in particular for MCVideo. MBMS bearer modeling has been accepted in SA#94, and evaluation procedure discussed and pre-agreed in AHI #86 and #88.

In SA4#95 and SA4#96, we introduced a solution for MCVideo, based on a convolutional FEC, for the key issue 8.1 (Forward Error Correction for MCVideo).

2. Reason for Change

Performance evaluation of a convolutional FEC shows that under low latency constraints, AL-FEC yields significantly better results than other considered FEC scheme: Raptor10, Reed Solomon, as described in the first solution within TR 26.881.

A second solution ("MCS dimensioning") recommends to only decrease the MCS value, instead of applying AL-FEC. This second solution is based on simulations evaluating a block FEC sheme with various FEC latency budget, with different MCS values.

However, amongst results from the first solution was that block FEC scheme are less performant than convolutional FEC. Performance of MCS dimensioning should be compared to the performance of AL-FEC, as done in this pCR.

Simulation conditions have been aligned as much as possible with simulations associated to solution 2.

These simulations have been performed and evaluated in close collaboration with the Institute of Telecommunications and Multimedia Applications (iTEAM) Research Institute of Universitat Politècnica de València (UPV), Spain and INRIA (Institut National de Recherche en Informatique et en Automatique, within the LEELCO laboratory).

3. Conclusions

<Conclusion part (optional)>

4. Proposal

It is proposed to agree the following changes to 26.881 v1.0.0

* * * First Change * * * *

10.X Channel Model for solution comparaison

10.X.1 Use Cases – Mission Critical Video

As in 10.4.1, 700 Mhz bands should be privileged for evaluation, as the spectrum for broadband PPDR are majoritarily allocated in these frequencies (see 5.3.1). However higher frequencies can be considered, in particular 1.4 GHz bands, as allocation by China.

A use case for this band and application is 3 km/h, i.e., a pedestrian use case. Higher speeds may be considered for diversity.

10.X.2 Simulation Method

Link level simulation:

- 751 MHz, 5 MHz.
- ETU1 x 2 model (1Tx, 2Rx antennas).
- Speed 3 km/h, 10 km/h, 20 km/h

General Method:

- While BLER > 0.1 %:
  - increase CNR, with a 0.2 step (CNR = CNR + 0.2)
  - perform a link level simulation for MCS 12 over 100.000 Mbsfn subframes.
- For the given CNR:
  - Generate the loss traces for MCS 12 / 13 / 14 / 15 / 16.
  - Evaluate the performances of various AL-FEC schemes (RLC, Raptor10, Reed Solomon) for different FEc latency budget : 240/480 ms, and 1 / 2 / 4 seconds. 1 packet per mbsfn subrame, 1 mbsfn subframe per frame.
  - Performance is express as achievable throughput for a combinaison of MCS and AL-FEC.

* * * Next Change * * * *

### 11.1.1.X	Performance of AL-FEC compared to MCS dimensioning.

#### 11.1.1.X.1	General

As mentioned in the key issue 9.4, the packet loss rate can also be reduced by decrementing the MCS. Combinaison of AL-FEC and MCS dimensioning are here evaluated in term of achievable throughput.

The solution follows the methodology given in 10.X. For the sake of clarity, figures of the following subclauses depict on the results for RLC and for an MDS FEC block code, scheduled according the block during mode.

Achievable throughputs can be compared to the usage of MCS dimensioning alone, set to 12 according the methodology given in 10.X. In that case, the achievable throughput, for an MBMS bearer allocating 1 subframe per frame within a 5 Mhz band, is 459 200 bps.

#### 11.1.1.X.2	3 km/h, 751 Mhz

Results of the simulation at 3 km/h, 751 Mhz are illustrated in figure 11.1.1.X.2-1:

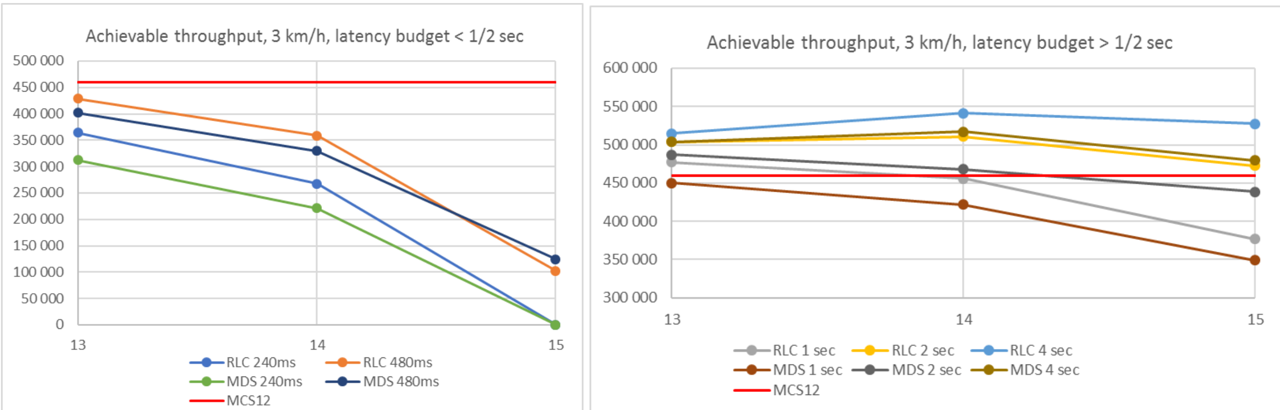

Figure 11.1.1.X.2-1 Achievable throughput (bps) for RLC and Reed-Solomon at 3 km/h, 751 MHz

This use-case (3km/h, 751MHz) has the largest coherence time. Not surprisingly, with a small latency budget (<1/2sec), AL-FEC codes can not recover largest bursts: at MCS=15, bursts are too large to be corrected by an AL-FEC.

However, with a 1 second budget, RLC provides similar performances at MCS 13 and 14 with the usage of MCS 12 only. With a 2 seconds budget, RLC allows to reach a throughput of 510 kbps. With a 4 seconds budget, 541 kbps.

NOTE:	Results shows that loss bursts get longer when the MCS is incremented. Consequently, for a fixed latency budget, performances of AL-FEC codes decrease for high MCS.

#### 11.1.1.X.3	10 km/h, 751 Mhz

Results of the simulation at 10 km/h, 751 Mhz are illustrated in figure 11.1.1.X.3-1:

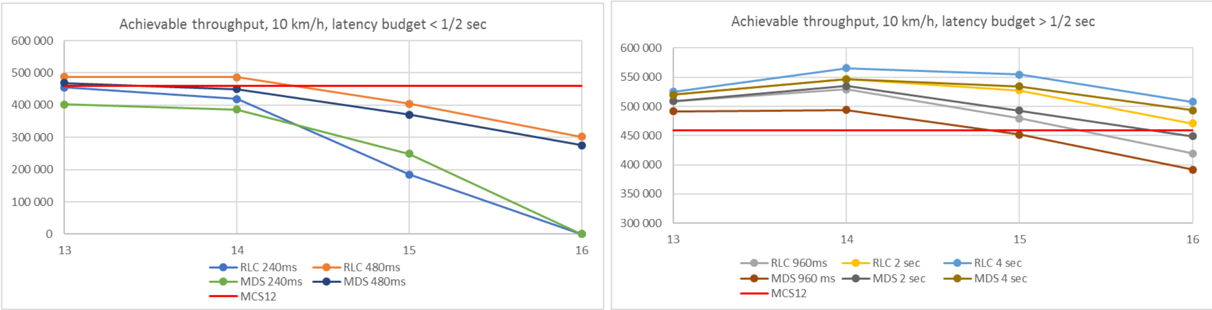

Figure 11.1.1.X.3-1 Achievable throughput (bps) for RLC and Reed-Solomon at 10 km/h, 751 MHz

At 10 km/h, 751 MHz, with a budget of 480 ms, a combinaison of RLC and MCS 13 or 14 is more performant than MCS 12 alone, achieving a throughput of 487 kps. With a higher budget, RLC allows a throughput up to 560 kbps.

11.1.1.X.4 20 km/h, 751 Mhz

Results of the simulation at 20 km/h, 751 Mhz are illustrated in figure 11.1.1.X.4-1:

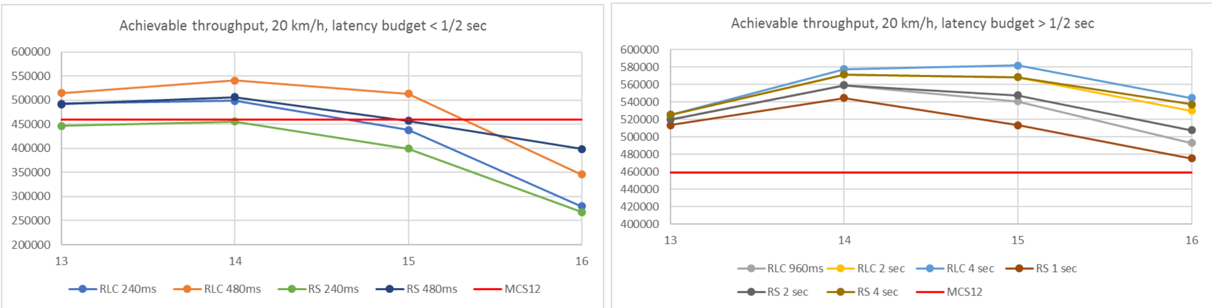

Figure 11.1.1.X.3-1 Achievable throughput (bps) for RLC and Reed-Solomon at 10 km/h, 751 MHz

At 20 km/h, 751 MHz, with a budget of 480 ms, a combinaison of RLC and MCS set to 13, 14 or 15, is more performant than MCS 12 alone, achieving a throughput of 541 kps. With a higher budget, RLC allows a throughput up to 582 kbps.

11.1.1.X.5 Performance for higher frequencies

Without simulation results, performances can be inferred from variations of the coherence time: coherence time, which is inversely proportional to speed and frequency, provides a good indication of burst duration.

For instance, at 1.4 GHz, loss burst durations are twice as short as at 700 MHz, and consequently, can be expected the same performances for RLC with half of the FEC latency budget. With half a second as FEC latency budget, a 3 km/h, 1.4 GHz, RLC would provide a throughput similar to the usage of MCS 12 alone. With only a full second, RLC would achieve a throughput higher than 500 kps.

Similarly, at 2GHz, 3 km/h, we can expect close performances to the ones at 700Mhz, 10 km/h (11.1.1.X.3).

11.1.1.X.6 Considerations about dynamicity of conditions for mission critical services

Usage of AL-FEC for mission critical services is particularly adapted to mission critical solution providers. MCS are currently configured semi-statically within the RAN, and the MCS value is generally mapped from the QCI IE providen by the control plane (MB2-C).

A mission critical solution provider, operating a commercial network has no exact control over the MB2 interface on the MCS value that will be used. Moreover, intervention zones for PPDR can suffers from degraded conditions for radio reception: e.g. fires can significantly affect radio propagation, radio infrastructure in a disaster area can be damaged, areas (basement) can be badly covered.

Dynamicity of these conditions can be addressed by adjusting the level of AL-FEC to provide extra-protection defined at the application level.

* * * Next Change * * * *

11.1.2 Solution evaluation

RLC corresponds to a current effort at IETF, which identified the interest of convolution FEC schemes for protection against losses under low latency constraints.

Evaluation of the RLC scheme within a MBMS channel shows gains against MDS and Raptor FEC block schemes for the considered latencies below 1 second, and provides better protection in all the conditions identified by the modelisation.

Usage of AL-FEC such as RLC allows to address the dynamicity of radio reception conditions and to make every effort to extend the coverage in a mission critical context. AL-FEC can also increase the achievable throughput.

Note this conclusion needs to be linked with the other evaluation

* * * End of Changes * * * *